



DACA42-03-C-0024

LOGANEnergy Corporation

U.S. Army Engineer Research and Development Center,
Construction Engineering Research Laboratory PEM Demonstration Project
Initial Project Report

Proton Exchange Membrane (PEM) Fuel Cell Demonstration
Of Domestically Produced PEM Fuel Cells in Military Facilities

US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
Broad Agency Announcement CERL-BAA-FY02

Construction Engineering Research Laboratory, Champaign, IL

December 7, 2004

Executive Summary

Under terms of its FY'02 DOD PEM Demonstration Contract with ERDC/CERL, LOGANEnergy will install and operate a Plug Power GenSys 5kWe Combined Heat and Power fuel cell power plant at ERDC/CERL, Champaign, Illinois. The site selected for the one-year demonstration project is adjacent to what is locally known as the Pole Barn (actually an equipment shed).

The unit will be electrically configured to provide grid parallel/grid independent service to the site, as well as be thermally integrated with a fan coil space heater to provide supplemental heating to the equipment shed during the test period. The methodologies to accomplish these tasks are found in the paragraphs that follow. Local electrical and mechanical contractors will be hired to provide services as needed to support the installation tasks. It is anticipated that the project will add \$4,737 of annual energy costs to CERL during the period of performance. The POC for this project is Bill Taylor whose coordinates are:

william.R.Taylor@erdc.usace.army.mil
217.373.4552

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Proposal – Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

1.0 Descriptive Title

LOGANEnergy Corp. Small Scale PEM 2004 Demonstration Project at the U.S. Army Engineer Research and Development Center (ERDC), Construction Engineering Research laboratory (CERL), Champaign, IL

2.0 Name, Address and Related Company Information

LOGANEnergy Corporation

1080 Holcomb Bridge Road
BLDG 100- 175
Roswell, GA 30076
(770) 650- 6388

DUNS 01-562-6211
CAGE Code 09QC3
TIN 58-2292769

LOGANEnergy Corporation is a private Fuel Cell Energy Services company founded in 1994. LOGAN specializes in planning, developing, and maintaining fuel cell projects. In addition, the company works closely with manufacturers to implement their product commercialization strategies. Over the past decade, LOGAN has analyzed hundreds of fuel cell applications. The company has acquired technical skills and expertise by designing, installing and operating over 30 commercial and small-scale fuel cell projects totaling over 7 megawatts of power. These services have been provided to the Department of Defense, fuel cell manufacturers, utilities, and other commercial customers. Presently, LOGAN supports over 30 PAFC and PEM fuel cell projects at 21 locations in 12 states, and has agreements to install 22 new projects in the US and the UK over the next 18 months.

3.0 Production Capability of the Manufacturer

Plug Power manufactures a line of PEM fuel cell products at its production facility in Latham, NY. The facility produces three lines of PEM products including the 5kW GenSys5C natural gas unit, the GenSys5P LP Gas unit, and the GenCor 5kW standby power system. The current facility has the capability of manufacturing 10,000 units annually. Plug will support this project by providing remote monitoring, telephonic field support, overnight parts supply, and customer support. These services are intended to enhance the reliability and performance of the unit and achieve the highest possible customer satisfaction. Scott Wilshire is the Plug Power point of contact for this project. His phone number is 518.782.7700 ex1338, and his email address is scott_wilshire@plugpower.com.

4.0 Principal Investigator(s)

Name	Samuel Logan, Jr.	Keith Spitznagel
Title	President	Vice President Market Engagement
Company	Logan Energy Corp.	Logan Energy Corp.
Phone	770.650.6388 x 101	860.210.8050
Fax	770.650.7317	770.650.7317
Email	samlogan@loganenergy.com	kspitznagel@loganenergy.com

5.0 Authorized Negotiator(s)

Name	Samuel Logan, Jr.	Keith Spitznagel
Title	President	Vice President Market Engagement
Company	Logan Energy Corp.	Logan Energy Corp.
Phone	770.650.6388 x 101	860.210.8050
Fax	770.650.7317	770.650.7317
Email	samlogan@loganenergy.com	kspitznagel@loganenergy.com

6.0 Past Relevant Performance Information

a) Contract: PC25 Fuel Cell Service and Maintenance Contract #X1237022

Merck & Company
Ms. Stephanie Chapman
Merck & Company
Bldg 53 Northside
Linden Ave. Gate
Linden, NJ 07036
(732) 594-1686

Four-year PC25 PM Services Maintenance Agreement...

In November 2002 Merck & Company issued a four-year contract to LOGAN to provide fuel cell service, maintenance and operational support for one PC25C fuel cell installed at their Rahway, NJ plant. During the contract period the power plant has operated at 94% availability.

b) Contract: Plug Power Service and Maintenance Agreement to support one 5kWe GenSys 5C and one 5kWe GenSys 5P PEM power plant at NAS Patuxant River, MD. .

Plug Power
Mr. Scott Wilshire.
968 Albany Shaker Rd.
Latham, NY 12110
(518) 782-7700 ex 1338

- c) Contract: A Partners LLC Commercial Fuel Cell Project Design, Installation and 5-year service and maintenance agreement on 600kW UTC PC25 power block.
Contract # A Partners LLC, 12/31/01

Mr. Ron Allison
A Partner LLC
1171 Fulton Mall
Fresno, CA 93721
(559) 233-3262

7.0 Host Facility Information

The Construction Engineering Research Laboratory is located in Champaign, Illinois. The Construction Engineering Research Laboratory (CERL) is part of the U.S. Army Engineer Research and Development Center (USAERDC), which is the Army Corp of Engineers' integrated research and development (R&D) organization. CERL conducts research to support sustainable military installations. Research is directed toward increasing the Army's ability to more efficiently construct, operate, and maintain its installations and ensure environmental quality and safety at a reduced life-cycle cost. Excellent facilities support the Army's training, readiness, mobilization, and sustainability missions. An adequate infrastructure and realistic training lands are critical assets to installations, which serve as platforms to project power worldwide. CERL also supports ERDC's R&D mission in civil works and military engineering.



CERL works closely with its Army customers to develop quality products and services and to help customers implement new technologies. User groups and steering committees have been established to help identify existing problems, establish research priorities, and provide input into the development of products. Many CERL products developed under this teamwork approach are in daily use, both within the Department of Defense and the

private/public sectors. An active technology transfer program ensures these products receive the widest dissemination among prospective users.¹

8.0 Fuel Cell Site Information

On February 20 2004, LOGAN representatives met with Bill Taylor of ERDC-CERL to perform a site evaluation for the fuel cell project. After visiting several possible buildings the team decided the optimum location to conduct the project was just west of the "Pole Barn" as shown in the figures to the left and below. The "Pole Barn" (equipment shed) is used by maintenance personnel to store various trucks and other motive equipment. This building also houses a small workshop with work benches and various machine tools. The fuel cell will be installed on a pad that will be located west of the Pole Barn and an adjacent access road. The fuel cell will have an 8 foot set off from the access road. The access road is frequently used in the winter by snow removal equipment as was well as by other equipment during the remainder



the year. The 8 foot set off was chosen to assure complete access by all vehicles and no protective bollards will be required at the fuel cell site. All fuel cell interfaces except for the propane fuel were identified at or inside the equipment. Those interfaces include phone, internet, make-up water lines, thermal recovery, and electric power lines. The fuel cell chosen for this demonstration project will operate on liquid propane gas (LPG). The LPG tank which will supply the fuel is planned to be located just to the left of the fuel cell figured above



9.0 Electrical System

The Plug Power GenSys 5C PEM fuel cell power plant provides both grid parallel and grid independent operating configurations for site power management. This capability is an important milestone in the development of the Gensys5 product on the pathway to product commercialization. The unit has a power output of 110/120 VAC at 60 Hz, and when necessary the voltage can be adjusted to 208vac or 220vac depending upon actual site conditions. At this site the unit will be connected to the facility in a grid parallel configuration dispatching power at 2.5kW for most of the period of performance. The photo at the left shows the electrical service panel where the fuel cell will be electrically coupled to the base utility grid at a 50 amp circuit breaker. The electrical service panel is conveniently located behind the exterior wall of the equipment shed adjacent to the fuel cell pad



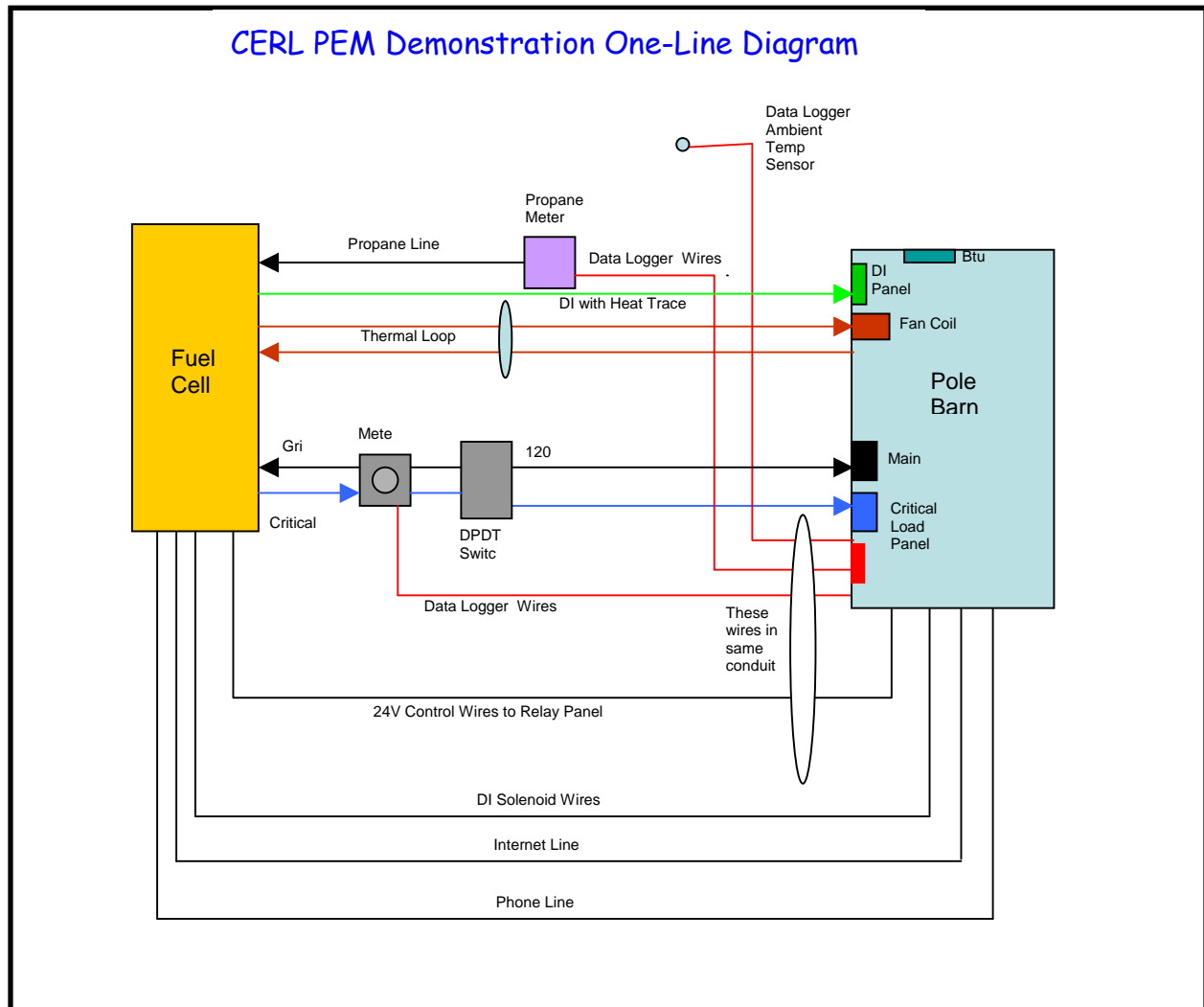
site. In addition, a separate grid-independent emergency panel will be installed to provide service to dedicated loads in the event of a failure of the utility grid feed to the site. That dedicated load will need to be identified with help from the CERL POC. While operating at 2.5kW(e) the unit provides nominally 27-30 amps of power to the effected circuits.

10.0 Thermal Recovery System

The GenSys5P delivers approximately 7,800 Btu/h to the customer heat exchanger at the 2.5kW power set point, which will be maintained during the course of the test period. In order to demonstrate this capability, LOGAN plans to install a Modine HD47L or similar fan coil unit in the equipment shed. A picture of the Modine 22,000 Btu fan coil unit can be seen below at left. The unit will be suspended from the equipment shed's wall next to the existing electric space heater (also seen below in the photo at right). The unit will be plumbed into the fuel cell's heat exchanger that will supply 7,800 Btu/h at 60 degrees C with a flow rate of 2.5gpm. The Modine HC 47L unit, pictured below, will provide a warm air output of 35 degrees C at 860 cfm.



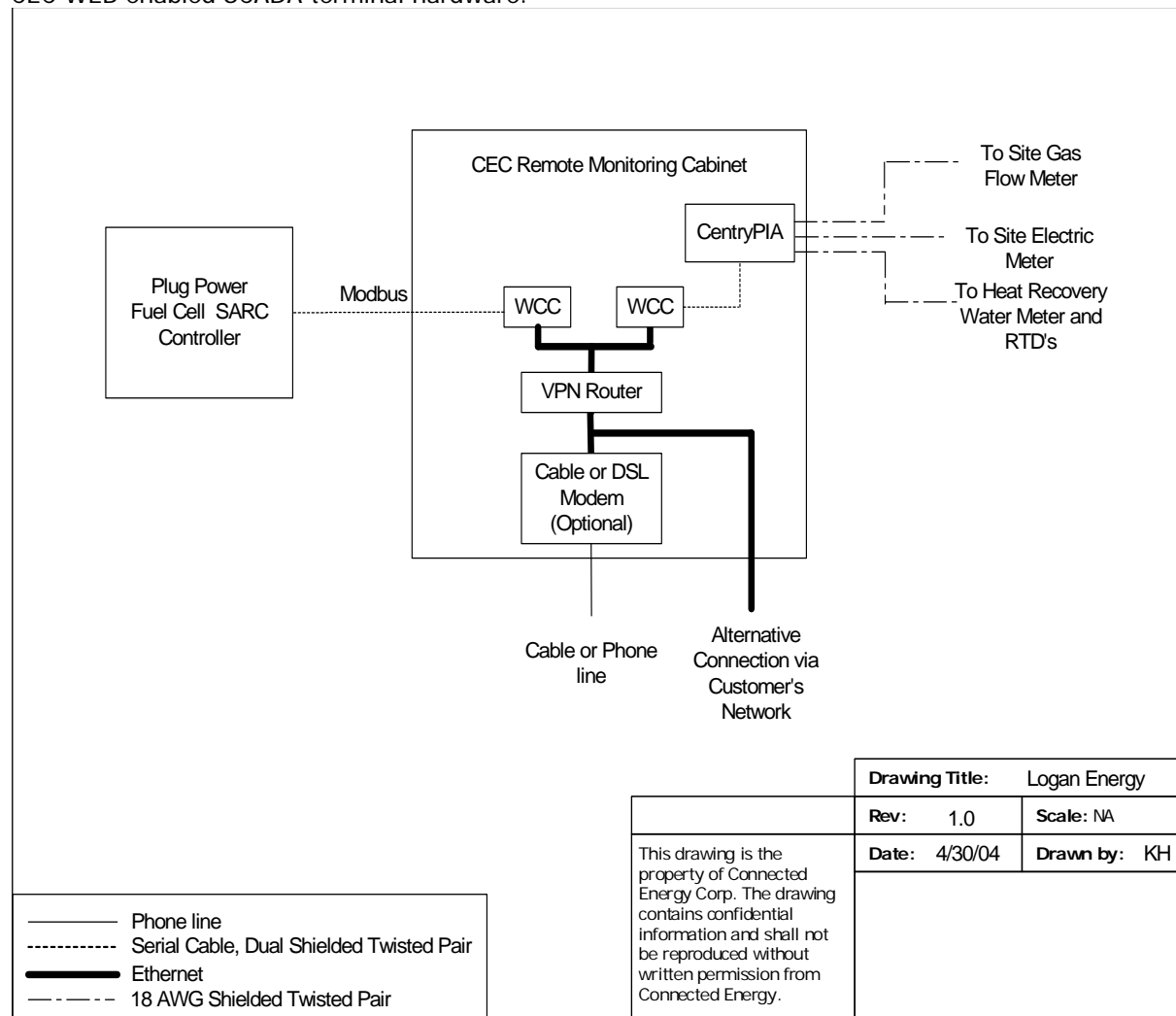
Installation One Line of Electrical, Mechanical, Thermal, and Communications Design



11.0 Data Acquisition System

LOGAN proposes to install a comprehensive data acquisition solution and also incorporates remote control, alarming, notification, and reporting functions. The system will pick up and display a number of fuel cell operating parameters on functional display screens including kWh, cell stack voltage, and water management, as well as external instrumentation inputs including Btus, fuel flow, and thermal loop temperatures. CEC's Operations Control Center in Rochester, New York maintains connectivity by means of a Virtual Private Network that will link the fuel cell to the center.

CEC WEB enabled SCADA terminal hardware.



LOGAN will procure high-speed Internet access to the fuel cell router from a local DSL or cable service provider. CERL will provide local dial tone to a phone jack that will be conveniently located in the Solar House to provide communications with the fuel cell data modem.

12.0 Economic Analysis

1) Water (per 1,000 gallons)	\$	1.67
2) Utility (per KWH)	\$	0.050
3) LP Gas (per gallon)	\$	1.50

Estimated First Cost

Plug Power 5 kW GenSys5P	\$	75,000.00
Shipping	\$	1,854.00
Installation electrical	\$	5,785.00
Installation mechanical	\$	7,289.00
Installation Thermal Recovery	\$	2,900.00
Web Communications Package	\$	11,925.00
Site Prep, labor, materials, general conditions	\$	1,025.00
Technical Supervision/Start-up	\$	4,800.00
Total	\$	110,578.00

Assume Five Year Simple Payback

\$ 22,115.60

Forecast Operating Expenses	Gal/Hr		\$/Hr		\$/ Yr
LP Gas @ 2.5kWH	0.53	\$	0.80	\$	6,267.78
Water Gals/Yr	14,016			\$	23.41
Total Annual Operating Costs					\$ 6,291.19

Economic Summary

Forecast Annual kWH		19710
Annual Cost of Operating Power Plant	\$	0.319 kWH
Credit Annual Thermal Recovery	\$	0.029 kWH
Project Net Operating Cost	\$	0.290 kWH
Displaced Utility Cost (Increase) or Decrease	\$	(0.240) kWH
Project Energy Cost (Increase) or Decrease	\$	(4,737.08)

13.0 Kickoff Meeting Information

The project kick-off meeting took place at 13:30 PM on November 22, 2004 at CERL Headquarters. See section 3 for the list of attendee's and their contact information. Also, find the agenda for the Kick-off Meeting in Section-3. Bill Taylor representing CERL and Chris Davis representing LOGANEnergy joined with other stakeholders at CERL Headquarters to discuss the purpose and scope of the project. Changes to the original proposal and remaining open issues have been documented.

Changes:

- 1) A back-up critical load will have to be identified because the Solar House load is all on one breaker and is expected to approach 100amps when everything is on. CERL is taking measurements to confirm. Likely back-up is to pick up internal equipment shed lighting as local outdoor lighting. LOGAN/CERL to make final determination during installation.
- 2) Made a determination at the Kick-off meeting that all interfaces can be more easily tied in at the equipment shed. Please see modifications made to the One-Line Diagram on page 9 of this report.
- 3) CERL to identify local propane company and put a contract in place with them. The propane tank used will be a 500 galloon tank.
- 4) CERL confirmed tying the fuel cell into their computer network was not an issue. They will provide an Ethernet connection at the equipment shed. LOGAN to tie fuel cell in at that termination point.

Open Issue(s):

- 1) Grid Inter-Connect Agreement may have to be executed at this site. CERL legal council reviewing utility (AmerenIP, formally Illinois Power) inter-connect agreement documents. If required an inter-connect study must be performed and will cost \$4,000. There will undoubtedly be additional cost for utility required protection relays as well

Bill Taylor has given the go ahead to complete the fuel cell installation however, it will not be started until this issue has been resolved to the satisfaction of all involved.

14.0 Status/Timeline

Please see Appendix 2 below.

Appendix 1.0

1. Sample form used to qualify the fuel cell for initial start and the project acceptance test.

Installation/Acceptance Test Report

Site: CERL Headquarters

Installation Check List

TASK	Initials	DATE	TIME (hrs)
Batteries Installed	MH		
Stack Installed	MH		
Stack Coolant Installed	MH		
Air Purged from Stack Coolant	MH		
Radiator Coolant Installed	MH		
Air Purged from Radiator Coolant	MH		
J3 Cable Installed	MH		
J3 Cable Wiring Tested	MH		
Inverter Power Cable Installed	MH		
Inverter Power Polarity Correct	MH		
RS 232 /Modem Cable Installed	MH		
DI Solenoid Cable Installed with Diode	MH		
Natural Gas Pipe Installed	MH		
DI Water / Heat Trace Installed	MH		
Drain Tubing Installed	MH		

Commissioning Check List and Acceptance Test

TASK	Initials	DATE	TIME (hrs)
Controls Powered Up and Communication OK	MH		
SARC Name Correct	MH		
Start-Up Initiated	MH		
Coolant Leak Checked	MH		
Flammable Gas Leak Checked	MH		
Data Logging to Central Computer	MH		
System Run for 8 Hours with No Failures	MH		

Section 2

Plug Power GenSys5P Specifications

- Dimensions 84 1/2" x 32" x 68 1/4"
- Performance Continuous Power Rating 5kWe (9kWth)
Power Output 2.5-5kWe (3-9kWth)
Voltage 120/240 VAC @ 60Hz
Power Quality IEEE 519, Grid Interconnect IEEE P1547
Emissions NOX <1ppm...SOX <1ppm
- Noise <60 dBa @ 1 meter
- Operating Conditions Temperature 0°F to 104°F
- Elevation 0 to 6000 feet
- Installation Outdoor
- Electrical Connection, Grid Parallel/Grid Independent
- Fuel, Propane
- Certifications Power Generation, CSA International
- Power Conditioning UL 1741— Electromagnetic Compliance FCC Class B —



Plug Power GenSys 5P



DOD FUEL CELL PROJECT KICKOFF MEETING AGENDA

Date: November 22, 2004

Location: Champaign, IL – CERL Headquarters

ATTENDEES	ORG.	PHONE	CELL	EMAIL
Bill Taylor	CERL	217.373.4552		William.R.Taylor@erdc.usace.army.mil
Nick Josefik	CERL	217.373.4436		n-josefik@cecer.army.mil
Melissa White	CERL	217.352.6511		Melissa.K.White@ERDC.usace.army.mil
Mike Ashby	CERL – DPU	217.373.6720		N/A
Scott Lux	CERL	217.373.4438		N/A
Mike Harvell	LOGAN		770.330.6400	mikeharvell@loganenergy.com
Chris Davis	LOGAN	860.872.1120	770.855.3917	cdavis@loganenergy.com
Chris Stack	CERL – IT	N/A		N/A

Status

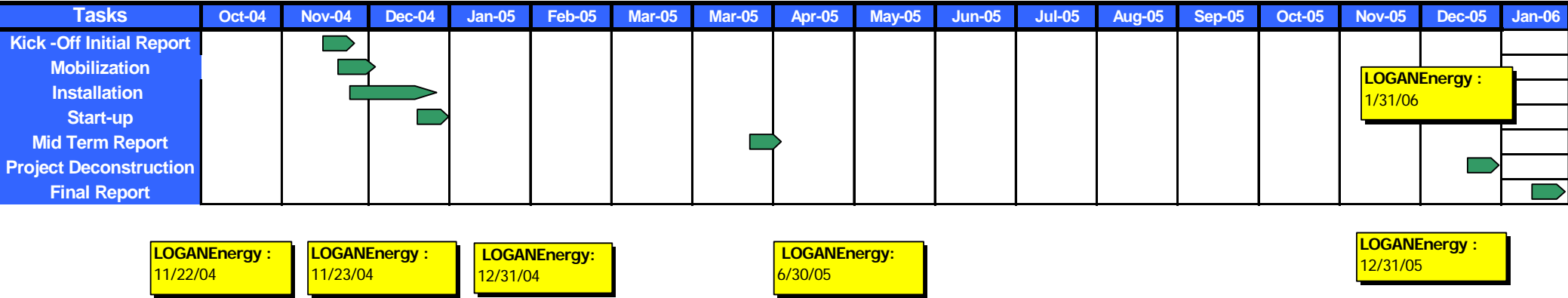
1. Introduction – All (5 mins)
2. Background & Expectations of PEM demonstration Program – Bill Taylor (5 mins)
3. Introduction to Project Team – Chris Davis & Mike Harvell (10 mins)
4. Fuel Cells System Project Description – Chris Davis & Mike Harvell – (20-30 mins)
 - Technology Overview OK OPEN
 - Project Installation Plan OK OPEN
 - Project Management Plan OK OPEN
 - Data Reporting and Communications OK OPEN
 - Environmental, base access and other security issues OK
 - OPEN
5. Unresolved issues...POC approval – (5-10 mins) OK OPEN
6. Site Tour – All (20 mins)

CERL Headquarters PEM Fuel Cell Demonstration Project

Installation, Monitoring, Performance Evaluations, & Reporting on One Plug Power PEM Fuel Cell At CERL Headquarters

Column Headings Indicate the Beginning of Each Month

Installation Schedule



ⁱ Mission Statement from CERL Web Site - <http://www.cecer.army.mil/td/tips/product/details.cfm?ID=458>